REMARKS

Claim 31 is independent and stands rejected under 35 U.S.C. § 103 as being unpatentable over Maydan et al. '612 ("Maydan") in view of Yang '699 ("Yang") and Downey et al. '281 ("Downey"). This rejection is respectfully traversed for the following reasons.

In order to expedite prosecution, Applicants' representative initiated a telephone interview with Examiner Fourson to discuss the merits of the present application. Examiner Fourson requested that the arguments be filed on the record after which he would reconsider the pending rejections. Applicants and Applicants' representative would like to thank Examiner Fourson for his courtesy in conducting the interview and for his assistance in resolving issues. A summary of the interview discussion follows.

Claim 31 recites in pertinent part, "forming an ***amorphous*** layer at a shallow region in a ***silicon substrate*** by irradiating a plasma containing He..." (emphasis added). The Examiner admits that Maydan does not disclose using He as the particular gas for forming an amorphous layer in a silicon substrate. The Examiner therefore relies on Yang as allegedly obviating this admitted deficiency of Maydan. However, Yang discloses only using He as an inert element for forming an amorphous layer of a ***polysilicon***, not the crystalline substrate of Maydan. Indeed, the polysilicon of Yang is part of a gate electrode having an entirely different set of processing parameters than a silicon substrate. Specifically, the He doped into the polysilicon of Yang is maintained therein as the impurity to subsequently diffuse into the gate electrode to effect a desired doping profile peak. Accordingly, the amorphization of the polysilicon in Yang does not correspond to the pre-amorphization of a substrate, prior to doping, in Maydan. The polysilicon doping of Yang is therefore not attributable to the substrate pre-amorphization process of Maydan. Assuming *arguendo* Maydan and Yang can be properly combined, such a combination does not suggest forming an amorphous layer using He in specifically a silicon substrate.

In the Advisory Action dated March 15, 2010, the Examiner maintains the pending rejection by concluding that "polysilicon is reasonably similar to monocrystalline silicon such that...[there would be] a reasonable expectation of success in employing He in place of Xe or Ar...in view of the disclosure by Yang that He, Xe and Ar are effective as the plasma used for amorphization." It is respectfully submitted that the Examiner's conclusion is in error. As noted above, Yang discloses only that He is effective as plasma used for amorphization of polysilicon *in that the He is intended to be maintained therein as a dopant* (col. 4, lines 48-50). Such a teaching does not suggest nor evidence a reasonable expectation of success of amorphization of a silicon substrate using He. This is because Yang desires implantation of the He as a dopant whereby the light, small physical characteristic of He can be implanted into the soft polysilicon. However, He is not suitable for implantation into the hard surface of a silicon substrate. There is no technical nexus between use of the light, small He as a ***implanted*** dopant into a ***soft*** polysilicon and use of He for amorphization of a hard substrate in which the He is not implanted as a dopant.

A rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art. *KSR International Co. v. Teleflex Inc.*, 82 USPQ2d 1385, 1395 (2007). The Examiner's conclusion, however, is not based on "known methods with no change in their respective functions." That is, the known methods are only forming amorphous layers of silicon substrates using relatively heavy elements Xe,Ar (Maydan), or forming amorphous layers of polysilicon using any elements (Yang). None of the cited prior art suggests, *nor enables*, forming an

amorphous layer of specifically a hard silicon substrate using specifically a light element such as He. Only Applicants have conceived of a viable manner in which such a ***combination*** (light element He used to form amorphous layer of hard silicon substrate) can be enabled.

During the interview, Examiner Fourson requested that Applicants submit arguments directed to the structural differences between polysilicon and a silicon substrate in relation to amorphization thereof using He, and why using He for amorphization of a silicon substrate would not have been obvious. In this regard, as noted above, Yang discloses using He for amorphization of a polysilicon layer and not a silicon substrate. Importantly, the polysilicon layer of Yang is part of the gate electrode rather than the substrate, whereby the He serves as a dopant to remain in the polysilicon layer to be subsequently diffused into the gate electrode to form a peak doping profile within the gate electrode (*see* col. 6, lines 1-5). Accordingly, Yang teaches amorphization of polysilicon using He as a dopant remaining in the polysilicon to create a peak doping profile within a gate electrode, and is completely unrelated to pre-amorphization of a silicon substrate in which the He would be subsequently removed from the silicon substrate.

Moreover, a single crystalline silicon substrate is physically and chemically quite different from a polysilicon layer in that the substrate is stronger and more stable. Accordingly, amorphization of a polysilicon layer and a silicon substrate require different processing parameters in that a silicon substrate has different functionality than a polysilicon layer used as part of a gate electrode, and that a silicon substrate requires heavier/larger elements such as Xe,Ar (Maydan) to penetrate the harder structure. Without relying on Applicants' specification as motivation, one of ordinary skill in the art would not replace the Xe,Ar of Maydan with He to make an amorphous single crystalline silicon substrate because helium is too light/small relative to Xe,Ar.

As noted above, Yang discloses He to penetrate the soft polysilicon layer for purposes of keeping the He therein for subsequent diffusion into the gate electrode. Accordingly, Yang teaches away from replacing Xe, Ar with He for amorphization of a silicon substrate, as there is no disclosed need or desire to keep the He in a silicon substrate. Moreover, He is a much lighter/smaller element than Xe, Ar so as to be less effective in penetrating the harder silicon substrate. The cited prior art does not suggest any reasonable expectation of success for amorphization of a hard silicon substrate using He, much less provide any objective reason to do so. The Examiner is directed to MPEP § 2143.01 under the subsection entitled "Fact that the Claimed Invention is Within the Capabilities of One of Ordinary Skill in the Art is Not Sufficient by Itself to Establish *Prima Facie* Obviousness", which sets forth the applicable standard:

> A statement that modifications of the prior art to meet the claimed invention would have been [obvious] because the references relied upon teach that all aspects of the claimed invention were ***individually*** known in the art is ***not*** sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. (citing *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993)).

In the instant case, even assuming *arguendo* that Maydan and Yang "teach that all aspects of the claimed invention [are] individually known in the art," it is submitted that such a conclusion "is not sufficient to establish a *prima facie* case of obviousness" because there is no ***objective*** reason on the record to combine the teachings of the cited prior art. As discussed below regarding new/unexpected results, only Applicants have recognized and considered the benefits than can arise from forming an <u>amorphous layer</u> ***in a silicon substrate*** by irradiating a plasma containing ***He***.

Similarly, claim 1 further recites in pertinent part, "introducing an impurity by applying a plasma to the shallow region of the silicon substrate; and applying light having an intensity peak at a wavelength of 375nm or longer on the silicon substrate so that said shallow region is excited

selectively and the shallow junction is formed electrically activated with the impurity." The Examiner admits that Maydan does not disclose the aforementioned feature, and therefore relies on Downey as allegedly obviating this admitted deficiency of Maydan.

In the Advisory Action, the Examiner maintains this rejection by asserting that "the annealing of Downey is a lamp annealing as disclosed by Maydan et al. ... and is disclosed to be suitable for activation after doping." However, the Examiner's conclusion does not take into consideration that Maydan ***as modified by the Examiner***, would result in the annealing of Downey causing the He to leap explosively outwardly from the Si substrate, thereby potentially roughening the surface of the Si substrate so as to damage the MOSFET by which it would not function normally (increased level of defectiveness). In this regard, accordingly, the cited prior art teaches away from using the activation annealing process of Downey in combination with a He-effected amorphous layer specifically in a silicon substrate (noting that Maydan ***itself*** does not disclose such a He-effected amorphous layer specifically in a silicon substrate).

Nonetheless, even assuming *arguendo* that the Examiner's basis for asserting obviousness is proper, it is respectfully submitted that the claimed ***combination*** can provide new/unexpected results thereby evidencing the criticality of the claimed ranges, so as to rebut any assertion of obviousness. As set forth in MPEP § 2144.05(III), Applicants can rebut a *prima facie* case of obviousness by showing the criticality of the claimed combination. "The law is replete with cases in which the difference between the claimed invention and the prior art is some range *or other variable* within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." (emphasis added) *In re Woodruff*, 16 USPQ2d 1934 (Fed. Cir. 1990). In the

instant case, it is respectfully submitted that the claimed combination can provide new and unexpected results relative to the prior art which are significant.

Specifically, as disclosed on page 5, lines 22-24 of Applications' specification, the inventors discovered that applying He plasma greatly improves the light absorption of the Si substrate. It follows that using He plasma in combination with the other steps of claim 31 (e.g., introducing an impurity by applying a plasma, applying light having an intensity peak at a wavelength of 375nm or longer, etc.) makes it possible to effect a higher light absorption coefficient for the substrate. Accordingly, the impurity can be electrically activated without generally changing the diffusion depth Xj of the impurity (*see* page 21, lines 13-17 of Applicants' specification; ΔXj being difference of diffusion depth after doping and after light application; *see* page 20, line 22 – page 21, line 1 of Applicants' specification). This is evidenced in Figures 3 and 4 of Applicants' drawings, and more specifically, Table 1 on page 21 of Applicants' specification.

Specifically, exemplary embodiments of the present invention are shown as Example A and Example B in which the ΔXj is 1.0 and 0.9, respectively, thereby minimizing diffusion depth of the impurity. In contrast, the Comparative Example has a small light absorption coefficient whereby the light energy reaches a deep level so that the impurity diffuses more deeply. In particular, the ΔXj of the Comparative Example is 10 so as to be a full order of magnitude larger than Examples A,B. That is, in the Comparative Example, the impurity diffuses an order of magnitude deeper than the shallow depth enabled by the present invention (*see* page 22, lines 7-13), thereby hindering formation of a shallow junction in the substrate of the Comparative Example.

Only Applicants have recognized and considered the aforementioned effects from forming an amorphous layer at a shallow region in a silicon substrate by irradiating a plasma containing He. As noted above, Yang is directed to a gate electrode and maintaining the He within the gate

electrode so as to be completely unrelated to formation of a shallow junction. Indeed, Yang discloses amorphization of a polysilicon layer using He as the impurity to be contained within the polysilicon layer to form a gate electrode. Yang does not suggest amorphization of a polysilicon layer for subsequent doping of the polysilicon layer, let alone for a shallow region in a substrate. Indeed, the amorphization of a polysilicon layer to form a gate electrode as taught in Yang is completely unrelated to pre-amorphization of a silicon substrate, prior to doping, to form a shallow region.

Again, while Yang desires the He to remain in the polysilicon layer, another one of the effects that can be enabled by the present invention is removal of He from the substrate after the amorphization upon annealing. In this regard, as described in Applicants' specification, because the coefficient of diffusion of He is high, little He remains in the substrate after annealing so as to reduce negative effects resulting therefrom. Further, the smaller size and lighter property of the He can make it possible to effect amorphization of the substrate without cutting the surface thereof.

"All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 165 USPQ 494, 496 (CCPA 1970).

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819 F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claim 31 is patentable for the reasons set forth above, it is respectfully submitted that all claims dependent thereon are also patentable. In addition, it is respectfully submitted that the dependent claims are patentable based on their own merits by adding novel and non-obvious features to the combination.

Based on the foregoing, it is respectfully submitted that all pending claims are patentable over the cited prior art. Accordingly, it is respectfully requested that the rejections under 35 U.S.C. § 103 be withdrawn.

CONCLUSION

Having fully responded to all matters raised in the Office Action, Applicants submit that all claims are in condition for allowance, an indication for which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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